A Novel Radial Basis Function Networks Locally Tuned with Differential Evolution for Classification: An Application in Medical Science

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ABSTRACT

The classification of diseases appears as one of the fundamental problems for a medical practitioner, which might be substantially improved by intelligent systems. The present work is aimed at designing in what way an intelligent system supporting medical decision can be developed by hybridizing radial basis function neural networks (RBFNs) and differential evolution (DE). To this extent, a two phases learning algorithm with a modified kernel for radial basis function neural networks is proposed for classification. In phase one, differential evolution is used to reveal the parameters of the modified kernel. The second phase focus on optimization of weights for learning the networks. The proposed method is validated using five medical datasets such as bupa liver disorders, pima Indians diabetes, new thyroid, stalog (heart), and hepatitis. In addition, a predefined set of basis functions are considered to gain insight into, which basis function is better for what kind of domain through an empirical analysis. The experiment results indicate that the proposed method classification accuracy with 95% and 98% confidence interval is better than the base line classifier (i.e., simple RBFNs) in all aforementioned datasets. In the case of imbalanced dataset like new thyroid, the authors have noted that with 98% confidence level the classification accuracy of the proposed method based on the multi-quadratic kernel is better than other kernels; however, in the case of hepatitis, the proposed method based on cubic kernel is promising.

Keywords: Classification, Differential Evolution, Diseases, Modified Kernel, Radial Basis Function Neural Networks (RBFNs)

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INTRODUCTION

Mistakes in medical diagnosis are a common phenomenon all over the world. Correct medical diagnosis of a disease is a cognitive process and depends on the experience and expertise of practitioner. A practitioner becomes expert only after successfully diagnosing sufficient number of diseases over several years. A study was made to show that intelligent system using machine learning approach can do better diagnosis than an experienced practitioner (Brause, 2001). The result shows that the most experienced practitioner can diagnose correctly (79.7%) where an intelligent system using machine learning technique gives better results (91.1%). From this result, one can get an idea that a human being with the help of an intelligent system can make complex data analysis without producing unacceptable level of errors.

A diagnosis by the physician in the form of diagnostic procedure using a few specific tools can be regarded as an attempt to classify an individual’s condition into distinct classes which allows making further decisions regarding identification of the disease and the appropriate treatment procedure. Significant progress has been made in the last couple of decades in computer understanding of natural language (Russel & Norvig, 2003), machine learning (Mitchell, 1997), pattern recognition (Hornegger et al., 2008), data mining and data warehousing (Cios & Moore, 2002; Berman, 2002; Breault et al., 2002), and more importantly for the medical community, in the development of new tools for the decision making process (Timpka, 1987, p.49; Reggia & Tuhrim, 1985).

Machine learning, a branch of artificial intelligence, concerns with the development of a system that can learn from the experience and improve their performance. Within this branch the problem of classification deals with building and training classifier systems which can assign a proper class for each input sample. For example, in breast cancer classification, the classifier should be able to assign each sample to either benign or malignant class, thereby helping identification of breast cancer. The task of classification is carried out in two steps: one is learning or training, other one is predicting or more properly perform classification. In the former a set of labeled data called the training set is considered to learn the function which maps observations to classes. In the later phase data for which the appropriate class is unknown are considered, and the classifying function, learned during the training phase is used to predict their classes.

Recent developments in medicine show that diagnostic intelligent systems using machine learning approaches can help physicians to make a definitive diagnostic. A reasonably good number of medical experts are available for on-line consultation covering almost the entire area of medical field; however their diagnosis is far from perfect. The conventional approach to build an intelligent system requires developing a set of rules using which analysis of the input data can carried out. However, the major problem with this approach is the difficulty of forming such rules. To overcome this problem, artificial neural networks (ANNs) (Haykin, 1994) have been applied as an alternative to conventional rule based intelligent systems. ANNs can be trained in absence of any knowledge derived from such rules, for which they are more helpful than traditional rule-based intelligent systems, particularly in the area of diagnosis of diseases (Selvi, 2001; Park, 2011).

As ANNs are not rule based, they have to be trained from examples presented to them. Therefore the success of ANNs depends very much on the training data using during the learning phase. Another problem in neural networks is the choice of network structure, weights, and the learning algorithm employed for training. In particular the convergence rate and suitability of solution depends mainly on learning algorithm.

Last few decade witnesses the usefulness of RBFNs (Powell, 1985; Broomhead & Lowe, 1988) in several fields including medical sciences. An important property of the RBFNs is that they form a unifying link among many different research fields such as function approximation, regularization, noisy interpolation,
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